

SEQUENCE LISTING

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<110> Chiang, Vincent Lee C.
 Tsai, Chung-Jui
 Hu, Wen-Jing
 <120> GENETIC ENGINEERING OF LIGNIN BIOSYNTHESIS IN PLANTS
 <130> 66040-9651
 <140> 09/530,663
 <141> 2000-07-11
 <150> PCT/US98/24138
 <151> 1998-11-12
 <150> 08/969,046
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<210> 1
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 <212> DNA
 <213> Populus tremuloides Michx. (aspen)

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 Met Asn Pro Gln Glu Phe Ile Phe Arg Ser
 5 10

60
112

aaa tta cca gac atc tac atc ccg aaa aac ctt ccc ctg cat tca tac
 Lys Leu Pro Asp Ile Tyr Ile Pro Lys Asn Leu Pro Leu His Ser Tyr
 15 20 25

160

gtt ctt gag aac ttg tct aaa cat tca tca aaa cct tgc ctg ata aat
 Val Leu Glu Asn Leu Ser Lys His Ser Ser Lys Pro Cys Leu Ile Asn
 30 35 40

208

ggc gcg aat gga gat gtc tac acc tat gct gat gtt gag ctc aca gca
 Gly Ala Asn Gly Asp Val Tyr Thr Tyr Ala Asp Val Glu Leu Thr Ala
 45 50 55

256

aga aga gtt gct tct ggt ctg aac aag att ggt att caa caa ggt gac
 Arg Arg Val Ala Ser Gly Leu Asn Lys Ile Gly Ile Gln Gln Gly Asp
 60 65 70

304

gtg atc atg ctc ttc cta cca agt tca cct gaa ttc gtg ctt gct ttc
 Val Ile Met Leu Phe Leu Pro Ser Ser Pro Glu Phe Val Leu Ala Phe

352

75	80	85	90	
ct a ggc gct tca cac aga ggt gcc atg atc act gct gcc aat cct ttc				400
Leu Gly Ala Ser His Arg Gly Ala Met Ile Thr Ala Ala Asn Pro Phe				
95	100	105		
tcc acc cct gca gag cta gca aaa cat gcc aag gcc tcg aga gca aag				448
Ser Thr Pro Ala Glu Leu Ala Lys His Ala Lys Ala Ser Arg Ala Lys				
110	115	120		
ctt ctg ata aca cag gct tgt tac tac gag aag gtt aaa gat ttt gcc				496
Leu Leu Ile Thr Gln Ala Cys Tyr Tyr Glu Lys Val Lys Asp Phe Ala				
125	130	135		
cga gaa agt gat gtt aag gtc atg tgc gtg gac tct gcc ccg gac ggt				544
Arg Glu Ser Asp Val Lys Val Met Cys Val Asp Ser Ala Pro Asp Gly				
140	145	150		
gct tca ctt ttc aga gct cac aca cag gca gac gaa aat gaa gtg cct				592
Ala Ser Leu Phe Arg Ala His Thr Gln Ala Asp Glu Asn Glu Val Pro				
155	160	165	170	
cag gtc gac att agt cct gat gtc gta gca ttg cct tat tca tca				640
Gln Val Asp Ile Ser Pro Asp Asp Val Val Ala Leu Pro Tyr Ser Ser				
175	180	185		
ggg act aca ggg ttg cca aaa ggg gtc atg tta acg cac aaa ggg cta				688
Gly Thr Thr Gly Leu Pro Lys Gly Val Met Leu Thr His Lys Gly Leu				
190	195	200		
ata acc agt gtg gct caa cag gta gat gga gac aat cct aac ctg tat				736
Ile Thr Ser Val Ala Gln Gln Val Asp Gly Asp Asn Pro Asn Leu Tyr				
205	210	215		
ttt cac agt gaa gat gtg att ctg tgt gtg ctt cct atg ttc cat atc				784
Phe His Ser Glu Asp Val Ile Leu Cys Val Leu Pro Met Phe His Ile				
220	225	230		
tat gct ctg aat tca atg atg ctc tgt ggt ctg aga gtt ggt gcc tcg				832
Tyr Ala Leu Asn Ser Met Met Leu Cys Gly Leu Arg Val Gly Ala Ser				
235	240	245	250	
att ttg ata atg cca aag ttt gag att ggt tct ttg ctg gga ttg att				880
Ile Leu Ile Met Pro Lys Phe Glu Ile Gly Ser Leu Leu Gly Leu Ile				
255	260	265		
gag aag tac aag gta tct ata gca cca gtt gtt cca cct gtg atg atg				928
Glu Lys Tyr Lys Val Ser Ile Ala Pro Val Val Pro Pro Val Met Met				
270	275	280		
gca att gct aag tca cct gat ctt gac aag cat gac ctg tct tct ttg				976
Ala Ile Ala Lys Ser Pro Asp Leu Asp Lys His Asp Leu Ser Ser Leu				
285	290	295		
agg atg ata aaa tct gga ggg gct cca ttg ggc aag gaa ctt gaa gat				1024
Arg Met Ile Lys Ser Gly Gly Ala Pro Leu Gly Lys Glu Leu Glu Asp				
300	305	310		

act gtc aga gct aag ttt cct cag gct aga ctt ggt cag gga tat gga		1072
Thr Val Arg Ala Lys Phe Pro Gln Ala Arg Leu Gly Gln Gly Tyr Gly		
315 320 325 330		
atg acc gag gca gga cct gtt cta gca atg tgc ttg gca ttt gcc aag		1120
Met Thr Glu Ala Gly Pro Val Leu Ala Met Cys Leu Ala Phe Ala Lys		
335 340 345		
gaa cca ttc gac ata aaa cca ggt gca tgt gga act gta gtc agg aat		1168
Glu Pro Phe Asp Ile Lys Pro Gly Ala Cys Gly Thr Val Val Arg Asn		
350 355 360		
gca gag atg aag att gtt gac cca gaa aca ggg gtc tct cta ccg agg		1216
Ala Glu Met Lys Ile Val Asp Pro Glu Thr Gly Val Ser Leu Pro Arg		
365 370 375		
aac cag cct ggt gag atc tgc atc cggt gat cag atc atg aaa gga		1264
Asn Gln Pro Gly Glu Ile Cys Ile Arg Gly Asp Gln Ile Met Lys Gly		
380 385 390		
tat ctt aat gac ccc gag gca acc tca aga aca ata gac aaa gaa gga		1312
Tyr Leu Asn Asp Pro Glu Ala Thr Ser Arg Thr Ile Asp Lys Glu Gly		
395 400 405 410		
tgg ctg cac aca ggc gat atc ggc tac att gat gat gat gag ctt		1360
Trp Leu His Thr Gly Asp Ile Gly Tyr Ile Asp Asp Asp Glu Leu		
415 420 425		
ttc atc gtt gac aga ttg aag gaa ttg atc aag tat aaa ggg ttt cag		1408
Phe Ile Val Asp Arg Leu Lys Glu Leu Ile Lys Tyr Lys Gly Phe Gln		
430 435 440		
gtt gct cct act gaa ctc gaa gct ttg tta ata gcc cat cca gag ata		1456
Val Ala Pro Thr Glu Leu Glu Ala Leu Leu Ile Ala His Pro Glu Ile		
445 450 455		
tcc gat gct gta gta gga ttg aaa gat gag gat gct gga gaa gtt		1504
Ser Asp Ala Ala Val Val Gly Leu Lys Asp Glu Asp Ala Gly Glu Val		
460 465 470		
cct gtt gca ttt gta gtg aaa tca gaa aag tct cag gcc acc gaa gat		1552
Pro Val Ala Phe Val Val Lys Ser Glu Lys Ser Gln Ala Thr Glu Asp		
475 480 485 490		
gaa att aag cag tat att tca aaa cag gtg atc ttc tac aag aga ata		1600
Glu Ile Lys Gln Tyr Ile Ser Lys Gln Val Ile Phe Tyr Lys Arg Ile		
495 500 505		
aaa cga gtt ttc ttc att gaa gca att ccc aag gca cca tca ggc aag		1648
Lys Arg Val Phe Phe Ile Glu Ala Ile Pro Lys Ala Pro Ser Gly Lys		
510 515 520		
atc ctg agg aag aat ctg aaa gag aag ttg cca ggc ata taactgaaga		1697
Ile Leu Arg Lys Asn Leu Lys Glu Lys Leu Pro Gly Ile		
525 530 535		

tgttactgaa catttaaccc tctgtcttat ttctttaata cttgcgaatc attgttagtgt	1757
tgaaccaagc atgctggaa aagacacgta cccacgtaa gacagttact gttccttagta	1817
tacaagctct ttaatgttcg ttttgaacct gggaaaacat aagttctcct gtcgccatat	1877
ggagtaattc aattgaatat ttgggttct ttaatgat	1915

<210> 2
 <211> 535
 <212> PRT
 <213> Populus tremuloides Michx. (aspen)

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 Ile Pro Lys Asn Leu Pro Leu His Ser Tyr Val Leu Glu Asn Leu Ser
 20 25 30
 Lys His Ser Ser Lys Pro Cys Leu Ile Asn Gly Ala Asn Gly Asp Val
 35 40 45
 Tyr Thr Tyr Ala Asp Val Glu Leu Thr Ala Arg Arg Val Ala Ser Gly
 50 55 60
 Leu Asn Lys Ile Gly Ile Gln Gln Gly Asp Val Ile Met Leu Phe Leu
 65 70 75 80
 Pro Ser Ser Pro Glu Phe Val Leu Ala Phe Leu Gly Ala Ser His Arg
 85 90 95
 Gly Ala Met Ile Thr Ala Ala Asn Pro Phe Ser Thr Pro Ala Glu Leu
 100 105 110
 Ala Lys His Ala Lys Ala Ser Arg Ala Lys Leu Leu Ile Thr Gln Ala
 115 120 125
 Cys Tyr Tyr Glu Lys Val Lys Asp Phe Ala Arg Glu Ser Asp Val Lys
 130 135 140
 Val Met Cys Val Asp Ser Ala Pro Asp Gly Ala Ser Leu Phe Arg Ala
 145 150 155 160
 His Thr Gln Ala Asp Glu Asn Glu Val Pro Gln Val Asp Ile Ser Pro
 165 170 175
 Asp Asp Val Val Ala Leu Pro Tyr Ser Ser Gly Thr Thr Gly Leu Pro
 180 185 190
 Lys Gly Val Met Leu Thr His Lys Gly Leu Ile Thr Ser Val Ala Gln
 195 200 205
 Gln Val Asp Gly Asp Asn Pro Asn Leu Tyr Phe His Ser Glu Asp Val
 210 215 220
 Ile Leu Cys Val Leu Pro Met Phe His Ile Tyr Ala Leu Asn Ser Met
 225 230 235 240
 Met Leu Cys Gly Leu Arg Val Gly Ala Ser Ile Leu Ile Met Pro Lys
 245 250 255
 Phe Glu Ile Gly Ser Leu Leu Gly Leu Ile Glu Lys Tyr Lys Val Ser
 260 265 270
 Ile Ala Pro Val Val Pro Pro Val Met Met Ala Ile Ala Lys Ser Pro
 275 280 285
 Asp Leu Asp Lys His Asp Leu Ser Ser Leu Arg Met Ile Lys Ser Gly
 290 295 300
 Gly Ala Pro Leu Gly Lys Glu Leu Glu Asp Thr Val Arg Ala Lys Phe
 305 310 315 320
 Pro Gln Ala Arg Leu Gly Gln Gly Tyr Gly Met Thr Glu Ala Gly Pro
 325 330 335
 Val Leu Ala Met Cys Leu Ala Phe Ala Lys Glu Pro Phe Asp Ile Lys
 340 345 350
 Pro Gly Ala Cys Gly Thr Val Val Arg Asn Ala Glu Met Lys Ile Val

355	360	365
Asp Pro Glu Thr Gly Val Ser Leu Pro Arg Asn Gln Pro Gly Glu Ile		
370	375	380
Cys Ile Arg Gly Asp Gln Ile Met Lys Gly Tyr Leu Asn Asp Pro Glu		
385	390	395
Ala Thr Ser Arg Thr Ile Asp Lys Glu Gly Trp Leu His Thr Gly Asp		
405	410	415
Ile Gly Tyr Ile Asp Asp Asp Glu Leu Phe Ile Val Asp Arg Leu		
420	425	430
Lys Glu Leu Ile Lys Tyr Lys Gly Phe Gln Val Ala Pro Thr Glu Leu		
435	440	445
Glu Ala Leu Leu Ile Ala His Pro Glu Ile Ser Asp Ala Ala Val Val		
450	455	460
Gly Leu Lys Asp Glu Asp Ala Gly Glu Val Pro Val Ala Phe Val Val		
465	470	475
Lys Ser Glu Lys Ser Gln Ala Thr Glu Asp Glu Ile Lys Gln Tyr Ile		
485	490	495
Ser Lys Gln Val Ile Phe Tyr Lys Arg Ile Lys Arg Val Phe Phe Ile		
500	505	510
Glu Ala Ile Pro Lys Ala Pro Ser Gly Lys Ile Leu Arg Lys Asn Leu		
515	520	525
Lys Glu Lys Leu Pro Gly Ile		
530	535	

<210> 3
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 <212> DNA
 <213> Populus tremuloides Michx. (aspen)

<220>
 <221> CDS
 <222> (1)...(1710)

<400> 3

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1	5	10	15

cca caa aac caa aac gca cca tcc tct cat gaa act gat cac att ttc	96	
Pro Gln Asn Gln Asn Ala Pro Ser Ser His Glu Thr Asp His Ile Phe		
20	25	30

aga tca aaa cta cca gac ata acc atc tcg aac gac ctc cct ctg cac	144	
Arg Ser Lys Leu Pro Asp Ile Thr Ile Ser Asn Asp Leu Pro Leu His		
35	40	45

gca tac tgc ttt gaa aac ctc tct gat ttc tca gat agg cca tgc ttg	192	
Ala Tyr Cys Phe Glu Asn Leu Ser Asp Phe Ser Asp Arg Pro Cys Leu		
50	55	60

att tca ggt tcc acg gga aaa acc tat tct ttt gcc gaa act cac ctc	240		
Ile Ser Gly Ser Thr Gly Lys Thr Tyr Ser Phe Ala Glu Thr His Leu			
65	70	75	80

ata tct cgg aag gtc gct gct ggg tta tcc aat ttg ggc atc aag aaa	288
Ile Ser Arg Lys Val Ala Ala Gly Leu Ser Asn Leu Gly Ile Lys Lys	

85	90	95	
ggc gat gta atc atg acc ctg ctc caa aac tgc cca gaa ttc gtc ttc Gly Asp Val Ile Met Thr Leu Leu Gln Asn Cys Pro Glu Phe Val Phe 100	105	110	336
tcc ttc atc ggt gct tcc atg att ggt gca gtc atc acc act gcg aac Ser Phe Ile Gly Ala Ser Met Ile Gly Ala Val Ile Thr Thr Ala Asn 115	120	125	384
cct ttc tac act caa agt gaa ata ttc aag caa ttc tct gct tct cgt Pro Phe Tyr Thr Gln Ser Glu Ile Phe Lys Gln Phe Ser Ala Ser Arg 130	135	140	432
gcg aaa ctg att atc acc cag tct caa tat gtg aac aag cta gga gat Ala Lys Leu Ile Ile Thr Gln Ser Gln Tyr Val Asn Lys Leu Gly Asp 145	150	155	480
agt gat tgc cat gaa aac aac caa aaa ccg ggg gaa gat ttc ata gta Ser Asp Cys His Glu Asn Asn Gln Lys Pro Gly Glu Asp Phe Ile Val 165	170	175	528
atc acc att gat gac ccg cca gag aac tgt cta cat ttc aat gtg ctt Ile Thr Ile Asp Asp Pro Pro Glu Asn Cys Leu His Phe Asn Val Leu 180	185	190	576
gtc gag gct agc gag agt gaa atg cca aca gtt tca atc ctt ccg gat Val Glu Ala Ser Glu Ser Glu Met Pro Thr Val Ser Ile Leu Pro Asp 195	200	205	624
gat cct gtg gca tta cca ttc tct tca ggg aca aca ggg ctc cca aaa Asp Pro Val Ala Leu Pro Phe Ser Ser Gly Thr Thr Gly Leu Pro Lys 210	215	220	672
gga gtg ata ctg acc cac aag agc ttg ata aca agt gtg gct caa caa Gly Val Ile Leu Thr His Lys Ser Leu Ile Thr Ser Val Ala Gln Gln 225	230	235	720
gtt gat gga gag atc cca aat tta tac ttg aaa caa gat gac gtt gtt Val Asp Gly Glu Ile Pro Asn Leu Tyr Leu Lys Gln Asp Asp Val Val 245	250	255	768
tta tgc gtt tta cct ttg ttt cac atc ttt tca ttg aac agc gtg ttg Leu Cys Val Leu Pro Leu Phe His Ile Phe Ser Leu Asn Ser Val Leu 260	265	270	816
tta tgc tcg ttg aga gcc ggt tct gct gtt ctt tta atg caa aag ttt Leu Cys Ser Leu Arg Ala Gly Ser Ala Val Leu Leu Met Gln Lys Phe 275	280	285	864
gag ata gga tca ctg cta gag ctc att cag aaa cac aat gtt tcg gtt Glu Ile Gly Ser Leu Leu Glu Leu Ile Gln Lys His Asn Val Ser Val 290	295	300	912
gcg gct gtg gtg cca cca ctg gtg ctg gcg ttg gcc aag aac cca ttg Ala Ala Val Val Pro Pro Leu Val Leu Ala Leu Ala Lys Asn Pro Leu 305	310	315	960

gag gcg aac ttc gac ttg agt tcg atc agg gta gtc ctg tca ggg gct Glu Ala Asn Phe Asp Leu Ser Ser Ile Arg Val Val Leu Ser Gly Ala 325 330 335	1008
gcg cca ctg ggg aag gag ctc gag gac gcc ctc agg agc agg gtt cct Ala Pro Leu Gly Lys Glu Leu Glu Asp Ala Leu Arg Ser Arg Val Pro 340 345 350	1056
cag gcc atc ctg gga cag ggt tat ggg atg aca gag gcc ggg cct gtg Gln Ala Ile Leu Gly Gln Gly Tyr Met Thr Glu Ala Gly Pro Val 355 360 365	1104
cta tca atg tgc tta gcc ttt tca aag caa cct ttc cca acc aag tct Leu Ser Met Cys Leu Ala Phe Ser Lys Gln Pro Phe Pro Thr Lys Ser 370 375 380	1152
ggg tcg tgt gga acg gtg gtt aga aac gca gag ctc aag gtc att gac Gly Ser Cys Gly Thr Val Val Arg Asn Ala Glu Leu Lys Val Ile Asp 385 390 395 400	1200
cct gag acc ggt cgc tct ctt ggt tac aac caa cct ggt gaa atc tgc Pro Glu Thr Gly Arg Ser Leu Gly Tyr Asn Gln Pro Gly Glu Ile Cys 405 410 415	1248
atc cgt gga tcc caa atc atg aaa gga tat ttg aat gac gcg gaa gcc Ile Arg Gly Ser Gln Ile Met Lys Gly Tyr Leu Asn Asp Ala Glu Ala 420 425 430	1296
acg gca aac acc ata gac gtt gag ggt tgg ctc cac act gga gat ata Thr Ala Asn Thr Ile Asp Val Glu Gly Trp Leu His Thr Gly Asp Ile 435 440 445	1344
ggt tat gtc gac gac gac gag att ttc att gtt gat aga gtg aag Gly Tyr Val Asp Asp Asp Glu Ile Phe Ile Val Asp Arg Val Lys 450 455 460	1392
gaa atc ata aaa ttc aaa ggc ttc cag gtg ccg cca gcg gag ctt gag Glu Ile Ile Lys Phe Lys Gly Phe Gln Val Pro Pro Ala Glu Leu Glu 465 470 475 480	1440
gct ctc ctt gta aac cac cct tca att gcg gat gcg gct gtt gtt ccg Ala Leu Leu Val Asn His Pro Ser Ile Ala Asp Ala Ala Val Val Pro 485 490 495	1488
caa aaa gac gag gtt gct ggt gaa gtt cct gtc gcg ttt gtg gtc cgc Gln Lys Asp Glu Val Ala Gly Glu Val Pro Val Ala Phe Val Val Arg 500 505 510	1536
tca gat gat ctt gac ctt agt gaa gag gct gta aaa gaa tac att gca Ser Asp Asp Leu Asp Leu Ser Glu Glu Ala Val Lys Glu Tyr Ile Ala 515 520 525	1584
aag cag gtg gtg ttc tac aag aaa ctg cac aag gtg ttc ttc gtt cat Lys Gln Val Val Phe Tyr Lys Lys Leu His Lys Val Phe Phe Val His 530 535 540	1632

tct att ccc aaa tcg gct tct gga aag att cta aga aaa gac ctc aga 1680
 Ser Ile Pro Lys Ser Ala Ser Gly Lys Ile Leu Arg Lys Asp Leu Arg
 545 550 555 560

gcc aag ctt gcc aca gcc acc acc atg tcc 1710
 Ala Lys Leu Ala Thr Ala Thr Thr Met Ser
 565 570

<210> 4
 <211> 570
 <212> PRT
 <213> Populus tremuloides Michx. (aspen)

<400> 4
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 Pro Gln Asn Gln Asn Ala Pro Ser Ser His Glu Thr Asp His Ile Phe 30
 20 25 30
 Arg Ser Lys Leu Pro Asp Ile Thr Ile Ser Asn Asp Leu Pro Leu His 45
 35 40 45
 Ala Tyr Cys Phe Glu Asn Leu Ser Asp Phe Ser Asp Arg Pro Cys Leu 60
 50 55 60
 Ile Ser Gly Ser Thr Gly Lys Thr Tyr Ser Phe Ala Glu Thr His Leu 80
 65 70 75 80
 Ile Ser Arg Lys Val Ala Ala Gly Leu Ser Asn Leu Gly Ile Lys Lys 95
 85 90 95
 Gly Asp Val Ile Met Thr Leu Leu Gln Asn Cys Pro Glu Phe Val Phe 110
 100 105 110
 Ser Phe Ile Gly Ala Ser Met Ile Gly Ala Val Ile Thr Thr Ala Asn 125
 115 120 125
 Pro Phe Tyr Thr Gln Ser Glu Ile Phe Lys Gln Phe Ser Ala Ser Arg 140
 130 135 140
 Ala Lys Leu Ile Ile Thr Gln Ser Gln Tyr Val Asn Lys Leu Gly Asp 160
 145 150 155 160
 Ser Asp Cys His Glu Asn Asn Gln Lys Pro Gly Glu Asp Phe Ile Val 175
 165 170 175
 Ile Thr Ile Asp Asp Pro Pro Glu Asn Cys Leu His Phe Asn Val Leu 190
 180 185 190
 Val Glu Ala Ser Glu Ser Glu Met Pro Thr Val Ser Ile Leu Pro Asp 205
 195 200 205
 Asp Pro Val Ala Leu Pro Phe Ser Ser Gly Thr Thr Gly Leu Pro Lys 220
 210 215 220
 Gly Val Ile Leu Thr His Lys Ser Leu Ile Thr Ser Val Ala Gln Gln 240
 225 230 235 240
 Val Asp Gly Glu Ile Pro Asn Leu Tyr Leu Lys Gln Asp Asp Val Val 255
 245 250 255
 Leu Cys Val Leu Pro Leu Phe His Ile Phe Ser Leu Asn Ser Val Leu 270
 260 265 270
 Leu Cys Ser Leu Arg Ala Gly Ser Ala Val Leu Leu Met Gln Lys Phe 285
 275 280 285
 Glu Ile Gly Ser Leu Leu Glu Leu Ile Gln Lys His Asn Val Ser Val 300
 290 295 300
 Ala Ala Val Val Pro Pro Leu Val Leu Ala Leu Ala Lys Asn Pro Leu 320
 305 310 315 320
 Glu Ala Asn Phe Asp Leu Ser Ser Ile Arg Val Val Leu Ser Gly Ala 335
 325 330 335

Ala Pro Leu Gly Lys Glu Leu Glu Asp Ala Leu Arg Ser Arg Val Pro
 340 345 350
 Gln Ala Ile Leu Gly Gln Gly Tyr Gly Met Thr Glu Ala Gly Pro Val
 355 360 365
 Leu Ser Met Cys Leu Ala Phe Ser Lys Gln Pro Phe Pro Thr Lys Ser
 370 375 380
 Gly Ser Cys Gly Thr Val Val Arg Asn Ala Glu Leu Lys Val Ile Asp
 385 390 395 400
 Pro Glu Thr Gly Arg Ser Leu Gly Tyr Asn Gln Pro Gly Glu Ile Cys
 405 410 415
 Ile Arg Gly Ser Gln Ile Met Lys Gly Tyr Leu Asn Asp Ala Glu Ala
 420 425 430
 Thr Ala Asn Thr Ile Asp Val Glu Gly Trp Leu His Thr Gly Asp Ile
 435 440 445
 Gly Tyr Val Asp Asp Asp Asp Glu Ile Phe Ile Val Asp Arg Val Lys
 450 455 460
 Glu Ile Ile Lys Phe Lys Gly Phe Gln Val Pro Pro Ala Glu Leu Glu
 465 470 475 480
 Ala Leu Leu Val Asn His Pro Ser Ile Ala Asp Ala Ala Val Val Pro
 485 490 495
 Gln Lys Asp Glu Val Ala Gly Glu Val Pro Val Ala Phe Val Val Arg
 500 505 510
 Ser Asp Asp Leu Asp Leu Ser Glu Ala Val Lys Glu Tyr Ile Ala
 515 520 525
 Lys Gln Val Val Phe Tyr Lys Lys Leu His Lys Val Phe Phe Val His
 530 535 540
 Ser Ile Pro Lys Ser Ala Ser Gly Lys Ile Leu Arg Lys Asp Leu Arg
 545 550 555 560
 Ala Lys Leu Ala Thr Ala Thr Thr Met Ser
 565 570

<210> 5
 <211> 1172
 <212> DNA
 <213> Populus tremuloides Michx. (aspen)

<400> 5

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atggctatga	tgaaggttaa	tagaggtatg	tgtgatttag	atatgtccag	cactagttt	180
ttgttggtgt	gatttctcat	gatgacgcga	aaattttata	tatatatata	atgaataata	240
tgattgatta	ttctctgtaa	ttttgtgaaa	tagataaaa	cagctcaatg	tgaggtgacc	300
agttgtcaaa	tgaccactcg	acttggggca	tggtgatttt	tcaaatcaca	actcaatttg	360
aaaactaaaa	ttaaaaaaaga	tttagattat	taaattatta	ggttaattca	cgggttggct	420
aatcaattat	tattaattaa	aacgatagta	tttttgataa	ttaaattaaa	attttattgg	480
atttgaatga	actcaattac	atcacaaaaa	acctaataca	attaatatct	tatgtgatat	540
aatttagaaa	tataaatgt	taacctttaa	atctcgagtt	tctcttataa	aaaacacgta	600
taattgggct	agatttaaca	gctattattc	aaactggcca	ggacaattat	taaaattaat	660
aatttattt	tttctataa	aagcacttcc	taattgttaa	aatatatgtc	taaacactaa	720
taataaaaatt	tatttgtta	tctttggcag	taggtgagag	gtgctgacaa	ataaatttagt	780
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tcaagtcaaa	aggccatttc	acaaccaacc	caaatggaa	cccaccaccc	ttccccggca	900
ttaaaatccc	taatctcacc	aacccaactc	cacagattct	tcaccaaactg	caactgattt	960
ttcaatcaat	gtttcccta	tactacccccc	ccaacaactc	cataataccc	aatttgcct	1020
ttcaccaacc	cccgctctcc	gtgccagcca	attctatatc	agcaggaatg	ctctgcactc	1080
tgcttctca	ggtctctac	cataagaaaa	cagagagcac	ctaaaactcg	ccatctctcc	1140

ctctgcacatct ttagcccgca atggacgcga ca

1172

<210> 6
 <211> 1180
 <212> DNA
 <213> Populus tremuloides Michx. (aspen)

<400> 6

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tatTTTTta	aaaatttaaa	aattaaatta	taacattttt	atTTTatccc	tcattaacta	180
aaatagggtat	ggtatagat	attcatgaag	ggagttatat	atcaaatgtat	attagttaa	240
ctatTTTgtat	atttatacc	tactcattac	ttatgaaata	aaaatttagt	atatttataa	300
aatattttatc	ggatttcagg	tattcatatg	aatattttat	tgattattat	ttattcaaca	360
aaaaataaaaa	caattaatat	gcatgtttga	agtttatata	tatattaagt	tagttttaga	420
tagatTTTgg	gtggggtaa	ttaatattca	taccctatct	actatctatc	aaataatcca	480
aataaattca	cctaaattag	gttgggtttg	tattcatcaa	gttaacat	aattgtat	540
ccgtaaagtaa	ctaaacaagt	acaaagactt	ctatTTTatc	ttatataat	ccataaagcc	600
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